



A N
E S S A Y
O N T H E
Origin, Nature, Uses, and Properties,
O F
A R T I F I C I A L S T O N E :

T O G E T H E R W I T H
Some OBSERVATIONS upon common natural
STONE, CLAYS, and BURNT EARTHS
in general.

I N W H I C H
The Durability of the latter is shewn to be equal,
if not superior, to the hardest Marbles.

B E I N G
The Result of many Experiments.

By DANIEL PINCOT,
Artificial Stone Manufacturer.

L O N D O N :

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M D C C L X X.

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INTRODUCTION.

 Rchitecture, or the art of raising
A regular and noble edifices, and
enriching them with proper or-
naments, is a science that hath
very much engaged the attention of great
and ingenious men in every age and nation,
since its first appearance in the world : and
elegant buildings, adorned with well-chosen
sculptures, are so universally admired, that
there is scarce a man to be found who feels
not a sensible delight in beholding them.
Whoever observes the strength, solidity, just
proportions, fine taste in the larger sculp-
tures, high laboured finishing of the lesser
ornaments, and elegance of design, still dis-
coverable in the remains of antique buildings,
will be immediately convinced that neither
study, labour, nor cost were spared in ac-
complishing those admirable piles.

But such rich and noble productions are very
rarely found among modern performances,

though we are not without ingenious and justly esteemed architects, who give proof of an ability in every respect equal to them, if they were possessed with the same means.

But the changes of times, and a different climate, altering the face of things, added to the exceeding great price of good sculptures, and the aversion of many persons to plain buildings, which induces them to employ bad artists for the sake of cheapness, (and perhaps sometimes for want of skill enough to chuse good ones) may be the principal causes of that vast heap of execrable ornaments (if I may call them ornaments) found about most of our English buildings.

This is no where more notorious than in London, and its environs, where there are few houses that are not more or less stuck about with carvings, or something in imitation of them, performed in a most miserable taste: and what is still worse, this is not confined to private dwellings, some of our public edifices being dressed up with the same poor embellishments, to the disgrace of a people
who

who boast of their knowledge in the polite arts.

Again, if we turn our eyes into the many gardens that are adorned with imagery, such a troop of distortions present themselves, as would incline a judicious beholder to believe the sculptors had intended to burlesque, and not imitate nature. And were it not descending too low, we might take notice of that prodigious swarm of vile unmeaning * notchings, found in all the burying-places in the kingdom. Hence it is easy to perceive, why some who are judges of what is excellent in these works of art, study a plain magnificence in their buildings; neither chusing the heavy expence of good ornaments, nor being able to bear the sight of bad ones.

But the exceeding great price of cutting fine figures in marble, or even Portland stone, prevents many more of the judicious from adorning their gardens, temples, &c. therewith; contenting themselves without sculptures, as they would be no better pleased with a dull Apollo, a limping Diana,

* The carvers call the cutting of grave-stones, notching.

a knock-kneed Hercules, or an impotent Mars, paired with an ill-shaped Venus, than they would be in seeing the simplicity of their plain mansions spoiled by mock ornaments, composed of awkward holes, queer zigzags, and long unnatural scratchings. But were persons of sufficient fortune willing to bear the expence of good sculptures for ornamenting the outsides of their buildings, or to decorate their gardens with fine statues, bustos, vases, &c. they are discouraged from doing it by the weather of this climate.

For it is a certain and well-known fact, that the weather in this island has so destructive an effect on Portland, Bath, and other rock stone, and even marble itself, when exposed to the open air, that their surfaces are soon destroyed, and in time the whole so greatly impaired, that not only the beauty but design and meaning also are lost; and this is most of all seen in and near populous cities, particularly in London, and its surrounding villages, where many of the modern artists are eye-witnesses to the ruin of their own works.

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This decay of marble and other stone is not confined only to our own country, but attends all climates, is more or less visible according to the different constitutions of the air, and occasions over the whole globe so broad and striking a scene of destruction, that it causes a painful sensation in almost every beholder. But it is most lamented by the antiquarian and the artist, the first having thereby totally lost many inscriptions, whilst others are so spoiled as to render their reading very difficult and uncertain; and the latter having thereby been deprived of many bright examples, which would have been well worthy of his imitation.

From this, though but a short view of things, it follows that the producing a material which will effectually remove all the foregoing inconveniencies, must certainly merit the attention not only of all who are concerned in buildings, and other works of elegance and ornament, but of the public in general.

To shew, therefore, that artificial stone, composed of proper materials, well manufactured and burnt, will fully answer the

above purposes, is the principal design of this treatise; in conjunction with some specimens of such work which are actually performed.

It has been the constant desire of almost every architect and lover of the fine arts, for many years past, that a work of this nature might be set on foot, and carried on by a person sufficiently skilful in manufacturing a proper composition, and having a competent knowledge in architecture, and other branches of the polite arts, in order to enable him to make a proper application of such a material. They have wished, likewise, that the material might be cheap and durable; of such a nature as to admit the fine antique statues, bustos, vases, &c. to be conveniently cast and burnt in it, and to furnish elegant ornaments of the lesser kind, at a moderate expence.

This they were not only naturally led to desire, but were convinced of its practicability, by considering the strength, durability, and cheapness of well burnt bricks, tiles, clinkers, &c. and also by observing the permanency of various productions in pottery
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and porcelain; but, above all, by seeing or having knowledge of numberless instances of what may be more properly called artificial stone, now actually existing in as full strength as when first made, in many ancient buildings in China, Egypt, Greece, Italy, Great-Britain, and other places. Partly from these considerations, but more fully from what will be advanced in the course of this work, it will appear, that making artificial stone, either that kind which is hardened in the air only, or that which is the work of fire, is far from being a modern discovery. As to the unburnt sorts, they have been several hundred years in use in several parts of Europe; but the burnt sorts have been much neglected through the want of knowledge in the nature of the materials, and the manner of moulding them. For, notwithstanding the pretensions of some who would be thought the inventors thereof, it appears from their productions, that the several adventurers in this branch of business, for above forty years past, have only a little varied in some of their materials and manner of treating them: hence, as in
several

several manufactories of porcelain and glass, some have made it better, and others worse.

This difference in the goodness of a material whose thorough burning and strength are such important requisites, added to my having experienced how little is known of the nature of these burnt bodies by far the greater part of the public, seemed to render it quite necessary, at the opening a new manufactory, to write something on so unknown a subject.

For when, about three years ago, I exhibited some performances of this sort at the new auction room (now the Royal Academy) in Pallmall, I observed that the greatest and almost the only encouragers of this work were persons who had some understanding in the nature of these burnt bodies, and consequently stood in no need of any arguments of mine to prove its strength or durability. But I found that a much greater number, under whose consideration these things had never happened to fall, could not easily be persuaded of any superior excellence in this over natural stone, when their reason
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and senses had no other evidence than the reasoning or rather assertions of the maker.

For this reason it is, that, besides a general account of the origin and progress of this art, I shall attempt to explain the nature and properties of artificial stone in such a manner, that any, who will take the trouble to examine the subject, may find sufficient evidence from their own understanding.

Yet I am well aware that, notwithstanding all that can be said or done, there are some persons so obstinately averse to the introduction of whatever they imagine has but the air of novelty, that they will be both blind and deaf to the plainest demonstration.

There are also others of the trading sort so extremely avaricious, that they will spare no pains, even at the expence of truth, to overturn any work, though ever so excellent in itself, or beneficial to the public, if they but apprehend the least future loss to themselves. These have already begun their outcry, and have prejudiced some few, who have not yet had an opportunity of undeceiving themselves.

But as every work must stand or fall according to its real merit, the public will not for any length of time be deceived by false representations.

It is therefore to the public I appeal, before whose tribunal every artist must bring his works, and leave them to determine how far they are meritorious.

S E C T. I.

ARtificial stone is a name which hath frequently been given to several compositions, on account of their answering the purposes of natural rock stone. These, though many, as being different from each other according to their various constituent parts and manner of making, may yet be reduced to two, viz. unburnt and burnt.

Though the last of these is the principal subject of this book, I shall take some notice of the former, when I come to speak of the nature and properties of the materials.

But the subject immediately before us is, the first discovery of burnt earths, or rather
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the art of burning earths to stone, and what those earths, before burning, really are, as to their component parts and first formation. Here the following method may be the shortest.

I shall lay it down as a proposition, that the discovery of burning earth till it become a stone was an easy one; and, in proof of my proposition, I shall introduce some observations concerning the original formation of clays, and what they consist of, together with their known properties and appearances.

Herein I shall be the more particular, as it will make an opening to what will be advanced in the third section, which, with this, will form an essay towards a general knowledge of burnt clays, or artificial stone; under which name, in this and the next section, is included all burnt earths in general, viz. bricks and tiles of all sorts, and all the various productions in pottery and porcelain; as being all of one and the same nature, differing only in appearances, according to their several degrees of fineness or

purity, and taking a variety of names, as applied in divers forms to various purposes.

Before we proceed to our leading proposition, it may be proper to mention some well-known facts, as a basis to found our reasoning upon, when speaking of things that are not so well known.

First, It is well known to potters, porcelain and glass makers, chymists, and many others, that the hardest stones, sands of all kinds, and many other natural bodies, when mixed with proper fluxes, may be vitrified, or converted into real glass, by the heat of a proper furnace.

Secondly, Several metals, and other minerals and fossils, alkaline and other salts, are proper vitrifying fluxes; and all these differ one from another in power or efficacy, when so applied, as much as they do in their outward appearances.

Thirdly, It is as well known that all natural clays contain in themselves the principles requisite to vitrification, and that in as
great

great a variety of powers, properties, and proportions, as there are sorts of known clays in the world; since scarce two of them are found to acquire the same degree of strength in the same degree of heat; and yet most of them, when exposed to a pitch of heat suitable to itself, become a hard, stony, or half-vitrified substance.

Fourthly, All the various colours in glass, enamels, &c. are given to them by metals and other minerals. Iron gives a red, and that brighter or heavier according to its preparation or purity; and it is observable, that by very much the greater part of the clays all over the world are of a red colour when burnt. Numerous observations of this kind might be produced of other metals, minerals, and fossils, with similar circumstances in clays; but, not being needful to the present purpose, they are here omitted.

These things being premised as known circumstances, and as they stand simply in common experience, we proceed directly to our first proposition, which is this:

That

That clay, by burning, would be converted into a hard, stony, indissoluble substance, was a discovery so easy and natural, that the first man who built an altar and sacrificed thereon could not possibly miss it, it being a sure attendant on such a transaction.

Should the following observations on the first altars, and the original formation of clays, prove the foregoing proposition to be true, the origin and first use of stone of burnt earths will be immediately and certainly known: and though this knowledge may be of but little or no importance in itself, yet it may serve as an introduction to some things that are both useful and entertaining.

That the first altars were built of lumps or cakes of earth, laid as bricks are in a wall, seems to be a matter quite agreed on by all who have examined into the transactions of men in the earliest ages of the world; to which we may add, that from many circumstances which may be gathered from the sacred books, and some other accounts, it appears that those earthen altars were much larger than what were in after times made
of

of stone; and, also, that a considerable quantity of wood must have been consumed in sacrificing.

This, therefore, being the case, it necessarily follows that there must have been a sufficient degree of heat to stonify that part of the altar immediately under the fire, provided, the earth of which it was built, was the same which we now call clay; which brings us to the next enquiry; which is,

How earths or clays were at first formed, and what they really are, or consist of.

According to the best philosophers, (so far as hath come to my knowledge) this earth, with regard to second causes, at first took not only its general form, but, also, the particular disposition of its interior part, by the ministry of water, assisted by the universal power of gravity.

Hence, from a chaotic state, in which they first lay, the various species of natural bodies, which constitute the solid part of this globe, subsided from the watery or fluid part. The finest parts of each, still floating, according to their several specific gravities, formed thereby divers strata, which have

since been in many places disturbed or broken. Thus far the philosophers and the present state of the earth agree.

What hath been asserted by Dr. Woodward, of the Deluge, affects not much the present enquiry; for the consequences are nearly the same, relating to clays in general, whether his accounts of that catastrophe be true or false. Yet what I have to advance, concerning clays, appears to be a new argument in favour of part of the last named hypothesis: but it is more particularly a confirmation of the foregoing account of the first formation of the world.

For, upon the strictest examination of clays, it appears, that they are not a distinct species of creation, having their parts, properties, and proportions of the principles of nature, formed peculiar to themselves, in like manner as stones, metals, and other distinct bodies; but they seem to be meerly compositions of the really formed parts of all the other species of substance that constitute this earth, and that in as great a variety of different proportions of those parts as so great a number of ingredients will admit.

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This consideration, compared with those common well known facts, mentioned in the beginning of the section, will soon make it appear what clays really are. Should this be thought not sufficiently clear, let those who doubt, either believe me, who have tried them myself, or try for themselves the following experiments.

Collect specimens of several of the many clays which are brought to London for various purposes; (or where this may not suit on account of distance, a sufficient number may be found in almost any county or district, in this or any other kingdom.) Carefully examine them while raw or unburnt, either by reducing them to dry powder, or diluting them in water, or any other means, so that their parts may be separated as much as they can be; and hence some of the component parts will be found as above described. Then take fresh lumps of the same clays, and, after drying, expose each to different degrees of heat till they run in the fire, nicely observing the change of appearance throughout the whole operation. This may all be done at one operation, in a small

wind furnace, by putting in about twelve pieces of each sort, and drawing out one piece of each, at certain periods, as the heat is raised. This being done, make artificial clays of such materials or principles as are discovered in the natural ones, exposing them, also, to the same degrees of heat: then compare all together, and I am persuaded, whoever does all this, will conclude, that clays are nothing more than the dust of stones, sands, metals, fossils, &c. each containing its own proper principle of nature. Hence we may see why alkaline and some other salts, sulphurs, &c. are no more discernable in raw clays than they are in other bodies, wherein though they exist, they are so enveloped or locked up as not to be the object of our senses, till by the force of fire they are set at liberty; and clays, being composed of the same bodies, however fine the parts, are yet sufficient to hold those salts, &c. as firmly as in larger masses. But when clays are exposed to such a degree of heat as to set those salts at liberty, they immediately assist the vitrification, and are a second time locked up, and escape our senses.

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It may, also, be observed, that most of the clays now found have acquired a firm tough consistence, by lying many years buried in large masses ; which, added, to their having thereby lost most of their looser salts, hath rendered them very unfit to promote vegetation, unless long exposed to the open air, or mixed with other matter : whereas at their first formation they must have been more loose, open, and replete with salts, and probably much more kindly to the growth of plants than that soil which hath since covered them.

This observation of clays growing tough by time, is confirmed by experience: for compositions of similar natures are found to be thus affected, if a proper degree of moisture is preserved in them.

I will just add, that that loose blackish soil or mould which covers great part of the earth, upon examination and a little reflexion, will be found to be nothing more than the exuviae of nature, the ordure of animals, and divers other matter, accidentally thrown together. There could, therefore, be none of it at the first creation, nor

much, till some years after; and consequently this was not at first the upper stratum of the earth, as some have thought.

Having thus far shewn what clays originally were, and now are, and compared the account, with what the philosophers say of the subsiding of the terrestrial matter at the creation, it naturally follows that the finest parts or dust of all the other bodies, must have been upheld or floated longer in the waters than the larger parts. This dust, at length settling also, and taking in its way a proper portion of salts, became the upper layer of the ground, fully furnished with the principles requisite for vegetation when assisted by water, or for vitrification when exposed to fire. Whoever will compare, what is contained in several books, which treat of making glass, enamels, porcelain, &c. and which describe chymical processes on minerals and fossils, with what hath been advanced above, concerning the original formation and constituent parts of clays, will not only find a confirmation of what has been said; but may make other discoveries both useful and entertaining, as well as save himself

himself the trouble of trying those experiments mentioned a page or two past.

As a conclusion of this part, we may observe, that, according to philosophers, antiquaries, and the foregoing description of earth or clay, our first proposition seems to be true, in all points; as the first sacrificers must have discovered some parts of their altars converted into firm stones.

A phenomenon like this, must certainly have been very surprising to persons so unacquainted with the properties of natural bodies, as the first inhabitants of the world must have been. And what could more command the attention of persons upon the search for whatever they apprehended might render their situation more agreeable, than to see that the same fire which consumed the victim and the wood, made the altar strong and indissoluble ?

This being once known, it was exceeding easy to find, that while the clay was soft, it might by the hand be fashioned at pleasure: and thus in all probability began the art of making stone of burnt earth, and divers vessels for domestic uses.

Nor may it seem extravagant to suppose that this discovery was not only the first in the world that contained curiosity as well as great usefulness, but that it might be the mother of another, perhaps equal, if not superior, in value.

For a desire of more knowledge in those first inhabitants being awakened by the former discovery, they might, by observing a variety in the matter of the earth, be naturally led to search deeper; and when they fell on a vein of metalliferous earth, some of which was either accidentally or designedly, for some purpose or other, put in the fire, the metal would soon become a fresh object of their attention. But though this discovery may seem as easily made as the former, yet its application to various purposes was much more difficult, and must have required a considerable length of time and experience to bring about in any tolerable degree of perfection. Yet we are assured that it was in practice in the days of Adam.

This is, also, a farther confirmation of the antiquity of the former discovery: for without stones of burnt earth they could not well
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make proper furnaces for purifying their ores. But should some say that they might have used for this purpose raw clay, the consequence is still the same; for they must have been first convinced that the clay would endure the fire.

Nor is it easy to conceive how they could fail in producing glass, though in a very limited manner: for, in the course of their operations by fire, either in burning clays, or smelting ores, bright drops of glass must frequently be found, which they might break from the parts to which they stuck, keeping them carefully till they had a proper quantity, after which they might be melted all together. And this I am inclined to think was the only known way of making, or rather finding, glass, till many ages after the Deluge, which rendered it so scarce and valuable as it seems to have been in those early times.

I cannot quit this part of the subject, without observing, that however inconsiderable the study of clays may appear to some, yet they certainly contain sufficient matter, not only to exercise usefully the mind, but,

also, to afford no small degree of gratification to the curiosity of the ingenious and speculative : and like other things which are neglected on account of their commonness, might lead to the explanation of many a phænomenon at present mysterious.

S E C T. II.

HAVING in the foregoing part taken notice of the antiquity of the art of making artificial stone, or as it was formerly (and perhaps more properly) called, stone of baked or burnt earth, we shall, in this part, take a brief survey of the progress of it in the first and some following ages of the world, with a few remarks concerning its application to various purposes in several nations ; and also offer an observation or two on the properties thereof, and of natural rock stone, from whence will appear the essential difference between the two species.

Whether any of the cities or other buildings before the flood were of burnt earth or brick, is not certainly known ; yet the affir-

mative appears by much the more probable supposition: for, allowing what hath been advanced in the former part to have any truth on its side, it follows that the sufficiency of the material for such purposes must have been known.

Again, the building of altars might suggest a plain opening to the art of raising walls; and some well known and very early transactions of the postdiluvians nearly confirm the matter.

The readiness which men discovered, almost directly after the Flood, for building a city and a tower with stones of baked earth; and their knowing so well the necessity of burning them thoroughly; plainly indicated, either their having experience herein themselves, or their being taught by some who were possessed of such experience by former works. For that it was a conviction of the strength and durability of burnt earth, that determined them in its favour, in preference to natural stone, appears pretty plain from the text; which shews, that they intended the building for a perpetual monument of their name and place, as well as for a general

neral rendezvous. But this knowledge of the permanency of thorough burnt brick, they could not have had, from their own experience as to time, that being evidently too short; nor did they know enough of the causes of the cohesion or decay either of natural or artificial bodies, to come at it by reasoning: they must, therefore, have been taught it, which appears to be really the case; for Noah and his sons were all not only then alive among them, but lived many years after, and had lived long enough in the old world to know the arts therein practised; and undoubtedly taught not only the above, but many others also to their several tribes, and that even for many years after the dispersion of mankind; and thus the knowledge of these and many other things was spread all over the world.

Hence it is probable that this business was in practice long before the Deluge. It is, however, very well known to have been in great use a few ages after, and from many hints which may be gathered from ancient writings, and some rare pieces that have been found, it appears that men soon grew
pretty

pretty dexterous in handling these earthen materials : and as they made vessels for domestic uses tolerably handsome, so also it seems probable that the first idolaters made their gods therein. If we compare the sacred writings with the first accounts of pagan mythology, it may not appear extravagant to suppose that images of Noah and his sons, with certain figures or hieroglyphics, signifying their teaching arts to the people, and their other actions, were the first works of this kind that were performed in the world : and in time, as men lost or corrupted what had been taught them concerning the true God, they deify'd these ancient fathers, and worshipped their images, giving them various names according to their several languages, or varying ideas.

Thus, in all probability, began the making of imagery, and with it idolatry, the progress of which appears to have been so rapid that in a few ages it might be a query whether gods or men were the more numerous. In this situation, it would have been a little wonderful if a people so very fond of god-making, should miss doing it in a material
so

so luckily adapted to the purpose as clay, though they soon used other materials also.

Hence arose their having a tradition that God made the first man of tempered clay, which, being impregnated with the celestial fire, took life, and became flesh and blood; and when persons found that their men of clay, by common fire, became lasting stones, it required but very little priestly jumbling to form the story of Prometheus. But thus to follow the uses that have been made of this material would be endless, and of no service; and even to mention all the greater instances thereof in the world would only serve to swell this work to a needless bulk. I shall, therefore, confine myself only to some remarks on its use in China, Greece, Italy, and England, the reason of which choice will soon appear.

Whoever hath travelled into China, or read their history, must know how much the Chinese boast of the great antiquity and perfection of this art in their empire, and of their being the first discoverers of it, particularly of that justly esteemed ware which they formerly called the precious jewel: and

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it is true that till of late, they have borne away the prize from all other nations, as to the fineness of the material itself.

But were their oldest records better understood, or their later historians more faithful, their claim to being the original inventors would have no better foundation than such claim would have if made by any other nation, as to burning earths in general; for the Chinese are most probably the offspring of Abraham by his concubines, which I could prove, were it worth the pains.

As to the perfection of their ware, if the matter were fairly examined, it might be found that the discovery thereof was more owing to accident than design: for in the course of so mighty a work as digging up, tempering and mixing the clay with proper matter, moulding and burning the bricks, or rather stones, for building that prodigious wall esteemed one of the wonders of the world, added to their having ready at hand the finest clay hitherto discovered, they might easily be led to that knowledge which they ascribe to their own great sagacity; and notwithstanding what they say of the vast antiquity

quity of their fine ware, it does not appear to be so old as the building of that wall. As to their painting and glazing they are modern.

Having made mention of the Chinese wall, it brings into my mind a remark thereon of Isbrand Ides's, in his travels over land from Moscow to Peking, which is to the following effect:

Upon his surveying that stupendous instance of human labour, and seeming not to know that the materials thereof were burnt earth, he expresses some wonder that a wall, which had stood upwards of two thousand five hundred years, should still have the appearance of one that had not been built above twenty; it being remarkably clean, and not grown over with moss and weeds, as old walls usually are.

This remark naturally introduces the intended observations on the essential difference between natural and artificial stone; which observations, though they may here seem wrong placed, and have the air of a digression, can have no ill effect on a subject like this.

Upon

Upon that single circumstance taken notice of by the noble traveller above named, if no other had ever mentioned the materials of that famous wall, we might have safely concluded that it was built of artificial and not natural stone, as may be seen by the least reflection on what follows.

That species of whitish rock stone commonly used in buildings, hath a great dependance on a certain degree of moisture for the maintenance of its texture. These stones, being a little dried, greedily imbibe the moisture of the air, if fitly exposed thereto, which is a nourishment and support to their strength; and where the heat of the sun, during its presence, deprives their surfaces of more moisture than can be supplied in his absence, the stone is soon defaced. Experience, also, shews that if stones of this texture have their pores locked or rather choaked up by any resinous or oily matter, as varnish or paint, so that the moisture of the air cannot freely enter their surfaces, they become weak and rotten much sooner than otherwise they would; and if their moisture is quite exhausted by

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the force of fire, they in appearance seem to take a different mode of existence, as in making lime.

Again, the pores of stones being in a continued connection throughout their whole substances, and their communication with the earth not being intercepted, they will receive fresh moisture therefrom, which, added to what they receive from the air, may be the reason why stone buildings are more decayed at top than at bottom, and why they are never found to perish from their centers outward. Hence, also, they have fresh supplies of the principles requisite for vegetation; and their moisture being sufficient for the nourishment of certain mosses whose roots find proper room to extend their fibres in the deep pores of the stone, these mosses form lodgements for dust mixed with seeds of other plants, which, growing and annually dying, leave fresh seeds and matter. Thus at length so great an encrease ensues as to cover the whole building, if totally neglected; and hence the lower ruins of buildings are preserved many ages after their tops are gone to dust.

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This vegetable cloathing on stone is constantly seen, except the aspect or general situation is unfavourable, and then a worse consequence takes place: for where these vegetables are denied growth the stone is destroyed, it being observable that where stones are covered with mosses, &c. their surfaces are preserved, and, on the contrary, where the one cannot grow the other is continually wasting*; which confirms our leading proposition, viz. that rock stones have a dependance on a certain degree of moisture for the maintenance of their texture.

We now return again to artificial stone, where, though the outward appearance is nearly the same, the internal properties are totally different, and far superior to all the common sorts of rock stone; provided the artificial be made of the best materials, and properly burnt, as that of the Chinese wall must have been, according to the foregoing remark.

* There are many other observations, on situations, matter in the air contradictory to the nature of stone, accidents in its first formation, ill management in workmen, &c. &c. omitted for want of room.

The difference between the former and this, arises from its cohesion being an indissoluble bond, which is not the case in any known natural bodies. Its pores are few, irregular, and have little or no communication with each other. It receives neither benefit or injury from the air, the earth, or their moisture. Whether its small unconnected pores are by any means choaked up, or left open, it matters not; yet it holds on its surface paint or varnish more firmly than any other substance I know of. It neither has any inherent moisture, nor, upon a foreign supply, will it retain a sufficiency thereof long enough to support the growth of any known vegetable, except it be laid in a situation constantly moist.

But as these properties in this material will be more fully treated of in another place, they are here but just mentioned in the form of meer assertions, only to shew the essential difference between the two species of stone; and that if Ibrand Ides had been conversant in things of this nature he would not have wondered at the permanency and cleanness of that wonderful wall.

But,

But, besides this wall, there are, according to the testimony of some travellers, many buildings in China, the greater part of which are of the same materials, although the country abounds in marble; and perhaps the Chinese may have reason to wish that their forefathers had used more marble, and less of their fine clay.

The next subject that should present itself to our view, is the uses that were made of burnt earths by the ancient Greeks and Romans. But as these, as well as the other works of those renowned artists, have already been the subject of treatises by several antiquaries; and as many specimens thereof are to be found in the cabinets of the curious, a particular description is here passed over; and, instead thereof, some observations are offered by way of comparison between those excellent artists above named and the Chinese, with regard to their differing earths.

A little consideration will make it appear a very unlucky circumstance, that the knowledge or possession of the finest and most durable material that could be adapted to the use of performing fine sculptures should be shut

up in a corner of the world, among a people notorious for being bad designers, and who have scarce any of that knowledge which gave so great fame to the Greek and Roman artists; while these either had not, or knew not, the use of any other earths proper for burning but such as were coarse and of a bad colour. Yet even on these they frequently bestowed much skill and labour; and hence it is plain that if they had been possessed of those finer materials, they would have made a much more noble use thereof than those who had them. Had this really been the case, it would not be absurd to suppose that they, instead of covering their burnt earths with marble, would rather have covered marble with burnt earth. However, from what is now seen of their works, it is evident they would have made many fine statues and other curious sculptures therein, the remains of which would now have been more valuable than those of marble.

The next review, is of what hath been done of this kind in England; and here but little can be said, except it be to expose or reprove the dullness of my countrymen, the
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case

case here being quite different, from both the foregoing. For the Chinese have both fine marbles and fine clays; the Greeks and Romans have fine marbles, and, as far as is discovered, but homely clays: but the English have fine clays, and but homely stones. They are, therefore, the more interested in a business of this nature, and yet they have most neglected it.

I cannot here say any thing more to the purpose than what is found in a book that was published about sixty-six years ago, intitled *The Country Purchaser, or Builders Dictionary*, a part of which is here transcribed.

The author, discoursing on brick-making, mentions some improvements therein as proposed by one Mr. Worlidge; who, among other articles, speaks of earthen pipes formerly made for the conveyance of water under ground at Portsmouth in Hampshire, and of grates and backs of chimneys made by Sir John Winter formerly of Charing-Cross: then, after speaking of the application of these materials to door and window frames, he (Mr. Worlidge) says “this is
“one of the most feasible and profitable

“operations I know in England to be neglected.” (Then the author himself goes on.)

“It is really my thoughts, much might be done concerning making of chimney-pieces, stone moldings, and architraves for doors and windows, and architraves or fascias for fronts of buildings, &c. if that men of this profession would but set their minds to work, to contrive some good composition of earth, and a way to manage it well in moulding, burning, &c. But (the more is the pity,) men of this profession are like the materials they work upon, viz. heavy and lumpish.

“It might be made a query, whether a composition of earth something like to common crockers earth, would not in some measure answer the design, since it is apparent, that whatever form the crockers are pleased to put their earth into, it retains it after drying and burning, although crocks, and such like things, are formed very thin: now, suppose that chimney pieces, or the like, were made in molds, and dried and burnt, when they
“came

“ came to be set up, if they were not
 “ thought smooth enough, they might be
 “ polished with sharp sand and water, or a
 “ piece of sharp sand, stone, and water. Or
 “ were there but care taken of such things,
 “ as these, (which are for ornament as well
 “ as use) when they are half dry or more in
 “ the air, then let them be polished over
 “ with an instrument for the purpose, either
 “ of copper or iron, or some hard body, and
 “ then leave them till they are dry enough
 “ to burn: ’tis my thoughts such would not
 “ want much polishing afterwards.

“ And let me further add, I am very apt
 “ to think that ingenious men of this profes-
 “ sion, might make very handsome and beau-
 “ tiful chimney pieces, stone moldings for
 “ doors, &c. fit for noblemens houses, and
 “ all others that would be at the charge.

“ What I would here propose, is by way
 “ of glazing, as potters do their fine earthen
 “ ware, either white or any other colour, or
 “ it might be vein’d in imitation of marble,
 “ or be painted and anneal’d with figures
 “ of various colours, or some history, per-
 “ spective or the like, which would be much
 “ cheaper,

“ cheaper, if not also as durable, and every
 “ whit as beautiful as marble itself.

“ And had I time, and room in this small
 “ treatise, I could here have added the me-
 “ thods of glazing, and painting of various
 “ colours, to have encouraged the lovers of
 “ such arts, to set their heads at work at it,
 “ so that I am inclined to think, we rather
 “ want art, or ingenuity, and industry, than
 “ materials to satisfy our greatest curiosity in
 “ building.

“ 'Tis not the baseness of our English
 “ materials, but want of skill and diligence
 “ in managing them, that makes our English
 “ Buildings, in the least measure inferior to
 “ any foreign ones: I well remember an in-
 “ stance of this nature, which was an ob-
 “ servation of an English ambassador, which
 “ was this, (viz.) that we ought not to be
 “ discouraged with our ignoble materials for
 “ building, which we use in England, in
 “ comparison of the marbles of Asia and
 “ Numidia; for, saith he, I have often, at
 “ Venice, viewed with much pleasure, an
 “ antiporch, after the Greek manner, erected
 “ by Andreas Palladio upon eight columns
 “ of

“ of the Roman order, the backs of stone
 “ without pedestals, the shafts or bodies of
 “ meer brick, three feet and half in dia-
 “ meter below, and consequently thirty-five
 “ feet high, as himself hath described them
 “ in his second book. Than which, saith the
 “ ambassador, mine eyes never yet beheld any
 “ columns more stately of stone or marble,
 “ for the bricks were first formed in a circu-
 “ lar mold, and were cut before they were
 “ burnt, into four quarters or quadrants, or
 “ more than four parts, for he could not
 “ certainly tell how many the sides were,
 “ afterwards in laying, jointed so close and
 “ nicely, and the points concenter'd so ex-
 “ actly, that the pillars appear one entire
 “ piece.

“ And therefore I would not have Eng-
 “ lishmen be disheartned, that we do here
 “ want those firm and solid stones, which
 “ nature hath furnished other nations with,
 “ but rather to exercise their ingenuity, to
 “ supply ourselves by art, with those things
 “ which Providence hath thought fit we
 “ should want, unless we would do so.

“ And

“ And if we can but bring such things to
 “ perfection, which have been here hinted
 “ at, it may hereafter redound to the honour
 “ of the English nation. I mention these
 “ things here purely to stir up inquisitive per-
 “ sons, to endeavour after an improvement
 “ of such arts, and that they might not be
 “ so stupid, as to suppose that either they,
 “ or their forefathers, were arrived at the
 “ *ne plus ultra* of this or any other art.
 “ And to persuade them if possible to throw
 “ off that slothful and dangerous principle
 “ of resting contented with being possess’d
 “ of the same degree of knowledge, which
 “ our predecessors had before us, and of
 “ thinking that they have skill enough, be-
 “ cause the barbarous part of the world
 “ doth not practise so much as they. But I
 “ would very fain, if it lay in my power,
 “ prevail upon mechanicks, to see what im-
 “ provements in their professions, they can
 “ bring forth.”

This quotation shews the state of these
 matters in the time of its author, who seems
 not to have known that making artificial
 stone was in practice several hundred years
 before.

before. For it appears that there are few, if any, of our cathedral churches, from five to seven hundred years standing, but what have some parts made in these materials, either of the burnt or unburnt species; but (if I mistake not) they are mostly of the latter, or that sort which hardens in the air only. But herein, if I am not greatly mistaken, the English fall infinitely short of the skill of the ancient Egyptians; for I have long suspected that porphyry, granite, and other hard marbles, (no quarries of which can be found,) are compositions. I could support this supposition by experiments, the account of which must at present be omitted.

During the reigns of the two last Henrys, the burnt kind seems to have been pretty much in use, several instances of which might be produced; but one may be sufficient.

In taking down an old gate which lately stood near Whitehall, there were found bustos of eight Roman emperors, in as many niches, all of burnt earth, and not in the least decayed by the weather. They are now in
the

the custody of Thomas Sandby, Esq; architect at Windsor Great Park.

It is observable that in the times of the above performances very little was known of moulds proper to deliver these kinds of materials with any certainty. Most part, therefore, if not all those ancient works must have been done by immediate modelling, which may be the principal reason why the practice thereof was discontinued; as it is pretty well known how few modellers, particularly good ones, were then in this kingdom.

Nor does there appear to have been any revival of this business till about forty years ago, when a considerable undertaking of this kind, (professedly under the name of artificial stone,) was set up by one Mr. Holt, at Lambeth, opposite York Stairs, who also wrote a small treatise setting forth the excellence of his manufacture; which treatise is the first instance, that I can remember, where the name, artificial stone, is applied to burnt earths; for whenever this name hath occurred in other authors, it seems to mean those compositions which acquire hardness in the air only.

The

The plan upon which the above manufacture was conducted was exactly the same as described by the author above quoted ; though Mr. Holt, in his book, talks much of his secret composition, and ascribes the whole to his own Invention, (as some others have done since.)

From several circumstances, it appears that this work met with tolerable encouragement for some years, till, the projector dying, the whole affair died also. But, it is evident from a considerable quantity of broken pieces now in my possession, that such a work could not have held many years in great esteem without improvement, had its author lived ; there being neither taste in the designs, nor neatness in the execution, though time has proved the materials durable in the severest trials. It is all covered on one side with an earthen ware, white glaze ; and some of it is poorly painted with blue ornaments, baskets of flowers, &c.

Mr. Langley the architect, also, made many things of this sort ; particularly some bustos, said to be tolerably executed.

What

What hath been attempted in this business by several hands for some years past is too well known to need any description. But it may be observed, in general, that whatever improvements have of late been made in these manufactures, they appear to be intirely owing to the unwearied diligence of several ingenious men who have searched this kingdom for proper materials to make porcelain, and to their endeavouring therein to equal the Chinese. I freely acknowledge that it was from some such I had those hints which rendered my experiments successful; and the public may be assured that if my present undertaking should meet with any tolerable encouragement, I will exert what abilities I have, yet farther to improve so pleasant and useful an art.

N. B. There are some notices which I have met with, in the course of many accidental conversations with persons who have travelled, and with whom at present I have no acquaintance. Several of them have observed, that there are to be seen in the Mogul's empire and other parts of the continent,

some very ancient buildings of a whitish stone, suspected to be artificial, and supposed to have been built soon after the Flood.

I just mention this by way of enquiry, that travellers, when they meet with such objects, may endeavour to inform themselves in this matter, which is easily done, thus :

Break from some part of the building a small piece, (if no bigger than a nutmeg it will do) heat it slowly till at length it may be put in a smart fire, then increase the heat to a degree that would melt glass. Let it cool gently, and the discovery is made. For if the stone is burnt earth, it will not suffer injury hereby, unless perhaps it be a little more glassified : but if it is natural rock stone, it will be a calx or limed. Any intelligence of this sort conveyed to me I shall esteem a favour.

S E C T. III.

HAVING, in the foregoing part, given a general account of artificial stone, so far as relates to its origin and progress in past times; it is the business of this part to attempt such an explanation of its nature and properties as to recommend its use in future; and to prove that the strength and durability of the burnt species is superior to white marble or common rock stone.

Artificial stone, as hath been before observed, is of two kinds, (viz.) unburnt and burnt; and these differ as little in their outward appearances, as was, in the former part, observed of the burnt artificial and natural stone; and have, also, the same essential differences in their natures and properties, arising from the same different causes in their cohesion; the first being by the ministry of water, and the other by fire.

Though the last of these is the principal subject of this work, it may not be amiss to offer some farther observations on the former,

as it appears most probable that this was in as great use in ancient times as the other; and is still an object worthy the attention of all who are concerned in building.

As the component parts, as well as the cause of their cohesion in this species of stone, are (or at least should be) the very same with those of natural stone, its nature and properties will be the same also: that is, the materials thereof should be so chosen and prepared, that upon forming the mass to its intended shape, the finest parts may take so orderly a disposition as to be firmly held in contact by the common power of gravity, in conjunction with a due degree of moisture and combining salts; which, from many experiments, appears to be universally the case in natural stones.

This may in some measure be observed in the operations on common mortars, stucco, plaister of Paris, and many others, and were there due care taken to restore certain acid principles which were driven off by the fire in burning the stones for such purposes, their strength, upon being re-made and dried to a proper degree in the air, would

be equal, and sometimes superior, to what they had in their pristine state: for when stones are burnt till they become a calx or lime, the salts that remain in them are mostly of the alkaline kind, and require to be duly balanced by some suitable acid, in order to render them indissoluble; which appears to be the reason why scum'd milk, and some other liquids containing certain degrees of acidity, are known to make these bodies more strong and durable; and some mineral acids perform this still better. The idea of fixing, or rendering alkaline salts indissoluble by balancing acids, may to some appear new; but in this case, the matter seems demonstrated by fact, or I am greatly deceived by my own experiments: for according thereto, compared with some natural appearances, the stonefying principle in some waters, the effects of which are so often seen, arises from mineral acids, in conjunction with that species of salts which upon burning natural stones are found therein.

This I could farther explain by several experiments, compared with some observations

tions on the changing hardneſſes of ſtones and ſtony matter, in their ſeveral ſtages, from their moiſteſt ſituation in the earth or quarry, to their drieſt ſtate in the air. But theſe, with many other things of this nature, muſt here be omitted for want of room.

There are various other methods of making artificial ſtone without burning; as by cementing their parts with gummous and divers other glutinous liquids, or by oily or refinous mixtures; but the inſufficiency of all theſe for any good purpoſes, renders them undeſerving of any farther notice.

Having thus run over a few particulars, towards explaining what principles ſhould be attended to, in making the moſt perfect unburnt artificial ſtone; I proceed immediately to the conſideration of that ſpecies, whoſe firm texture is a partial vitrification, or which hath glaſs for its bond of coheſion.

As I have, in a former part, given ſome deſcription of clays in general, and therein ſhewed, ſo far as I have diſcovered them, what are the various materials in their compositions; and as, alſo, by comparing them with certain well known facts, I have ex-

plained the means whereby they so constantly become such half-vitrified indissoluble substances, after being exposed to suitable degrees of heat; what has been offered may afford sufficient testimonies touching the nature of burnt earths in general, the permanency of which, when properly fired, is universally known by the constant applications thereof to divers purposes, in numerous forms, such as bricks, tiles, pottery, &c.

Having, therefore, treated on these inferior kinds, there only remains porcelain, and the best artificial stone, as matters for farther consideration. These last, being in the strictest sense but one species, and having the same identical constituent parts, need no other distinctions, than fine and coarse; the degrees of grinding being proportioned to such magnitudes as are required in their application. But the finest of these, being well known as an article in common use, and having already been treated of in other books, may here be passed over, that we may bring forward the principal subject intended, viz. an explanation or proof of that
propo-

proposition, which stands as a title to this section, and may be thus stated.

That kind of artificial stone, which hath all the requisites hereafter described, is far superior, in strength and durability, to white marble, or common rock stone. The shortest method for accomplishing this, with any tolerable evidence, to those who have not hitherto studied, upon what principles such bodies exist, may be by first offering some general remarks on their ingredients singly; secondly, by naming those requisites which constitute a sound well-finished piece of work; and then, by shewing whereon those requisites depend. Hereby we shall form distinct heads, the several explanations of which will not only lay open the nature of such compositions, but, also, prove, that their cohesion is really glass; whence it must follow, from common observation, and well-known experience, that our first proposition is true, provided things are conducted as here described. For though diverse compositions, called artificial stone, have been, and hereafter may be produced by persons wholly ignorant of the nature or properties

of their ingredients singly, or of their effects when combined ; yet a competent knowledge herein, besides constant circumspection through every operation, is absolutely necessary to the performance of these works, with their proper requisites.

To proceed, with all possible clearness, it should be first observed, that these expressions, vitrifiable, unvitrifiable, too much or too little of vitreous materials, &c. must be understood in limited senses, meaning only, that they are such, or otherwise, as exposed to determined degrees of heat.

Again, various combinations, each containing several ingredients for producing either partial or entire vitrifications, may be so composed, that some are glassified with moderate heats ; and another set requires something more ; whilst a third class demands intense fire, to awaken their vitreous principles. Hence these substances attain several degrees of hardness ; it being observable, that glass and glassy bodies are more or less strong, according to the different forces of fire requisite to their vitrification. Let it be observed, bye the bye, that the
weakest

weakest of these are known to endure the weather beyond marble. Things being thus premised, I pass on, and observe that as all clays are compositions, so likewise every combination, made by art, with similar ingredients and properties, may be called clay, though some particular principles of the first are purposely omitted in the last. Hence we have two classes of clays, viz. natural, and artificial.

Notwithstanding there is such an infinite variety of natural clays in this kingdom, not one hath hitherto been found sufficient, without other ingredients, to make artificial stone, with all its requisites; the reasons of which, regarding their general species, need no mention, being already obvious. Yet there are some few, which, judging only from appearances, bid fair for the purpose, being fine, and if in small subjects, are, when exposed to moderate heats, of middling strength, and well coloured. These, from experiments, appear in the main thus composed: for a basis they have fine sands and calxes, much lead and some tin, both naturally calx'd, and iron, and strong fluxing salts, blended with bituminous principles, &c.

all which being intimately united, by long lying together, are become tough and soapy. Hence, in artificial clays they make good auxiliaries, but bad principals; it being evident to those skilled in these matters, that this set of ingredients, proportioned as they are in nature, must be insufficient for large works, the vitrifiable parts being too tender and abundant, as will appear hereafter. This being the case, recourse must be had to artificial clays. These may be divided into two sorts; one without, the other with, a certain portion of natural clays.

The first kinds are most excellent, their component parts being only such bodies as are free, both from fluxing and colouring metals, or tinging sulphurs; or at least, possessing none but what are volatile, like the blackness in flints, pebbles, &c. Another property of these ingredients, is a perfect uniformity in their effects, through every operation. The vitreous parts, also, are of that sort, before noted for being most obstinate in the fire, or requiring the strongest heats to vitrify them. These compositions, when properly burnt, have at once the strength of porphyry,

porphyry, and the brilliant whiteness of the finest statuary marble; but, on account of certain inconveniences, they become at present too expensive for common use: and therefore, till a farther discovery can be made, for working them with more freedom, we must be content with lowering the quality, by mixing some portion of the natural clay. Thus is produced the next class of artificial clays, the nature of which will more fully appear from the means whereby the following requisites are produced, or their contrary avoided.

Good artificial stone should, in the first place, retain perfectly the form it receives from the mould; secondly, exactness in its dimensions; thirdly, it should be free from cracks, or fire flaws; fourthly, it should be equally burnt, or have an even firmness throughout its whole substance; fifthly, it should have but small unconnected pores; and lastly, a bright stone colour should grace the whole.

To begin with the *First* of these, which is a perfect retention of figure, or maintaining exactly

exactly that particular shape received from the mould; this may well be esteemed a leading requisite, since a want thereof renders all the rest utterly useless.

In the general relation, concerning this material, it hath been described as a substance whose cohesion and strength depend on a partial vitrification. It is easy to conceive, that there is in these compositions, considering their intended applications, a necessity for limiting their vitrification, or rendering it but partial; for, were this total, any particular device would be impracticable, without a very different, and more expensive mode of operation. On the contrary, were the portion of vitreous matters omitted, there would not be the least degree of strength; and, of the many gradations between these extremes, there must be but one that best maintains a balance; whence it will appear, that the unvitriifiable ingredients supply the office of supporters to their fusible companions; and that these two grand principles require not their quantities, but their powers, to be in exact equilibrium; for the vitriifiable parts being rendered too abundant
by

by an intense heat, the supporters will float, and hence distortions must ensue.

Again, it is requisite that the unvitriifiable materials be of such a nature, that during proper heats, they may retain sufficient strength, not only to support the nearest adjoining parts, while in fusion; but also, that a small portion thereof may sustain the entire weight of the whole subject. There is a difficulty attending this, that exceeds whatever is observable in any other kindred operation.

Besides the above-mentioned circumstances, there are a variety of others that are productive of deficiencies, not only in this, but also in the next requisite, to which we proceed, considering them together, as being nearly connected. Therefore,

Secondly, Several pieces, delivered from the same mould, should, when burnt, not only retain exactly equal dimensions, but also possess that dimension particularly required.

Notwithstanding a precise production of this requisite is within reach, provided the manufacturer understands the constitution of his material; yet, experience hath proved,
by

by several instances of mistake, that it demands, in many respects, a scrupulous exactness, far exceeding what is required in smaller works of porcelain; both with regard to the choice, and also the adjusting of the proportions of its component parts. For, all clayey compositions diminish in their magnitudes by drying and burning; and this diminution not only varies continually, by diversity of accidents, either through inequality of moisture during moulding, or by irregular heats in burning. But in numberless degrees, according to the very different qualities of natural clays, and the proportions thereof, that are incorporated with the other ingredients, all these things require constant attention, since there are compositions, that by drying and burning, lessen their extent a fourth part; whilst, on the contrary, others decrease but a thirtieth. That which is made by myself, for common purposes, looses one part in twenty-three: but even this is no longer certain, than while the manufacturer's eyes are open; for, the constitutions of natural clays, not only in diverse sorts, but in several samples

from

from the same pit, are so various and uncertain, that no standing recipe can be performed; every fresh parcel of clay demanding new experiments to determine the proportions.

This abatement of extension is the cause of failure in the next requisite before mentioned, which was,

Thirdly, Freedom from cracks, or fire-flaws.

Though these are frequently but of small consequence, they should, if possible, be avoided, being defects: yet, in some pieces, they are almost unavoidable, there being few subjects that have not, by necessity, their entire weight sustained only by some one part.

Consequently, the whole is not equally at liberty to decrease its extent; and hence, in ponderous subjects, notwithstanding diverse contrivances, and much care, chasms or flaws will sometimes happen. Nor is this marvellous, when it is considered, that, at the very instant the casts are delivered from their moulds, a diminution commences,

and continues not only through drying, without, but also in the furnace, until their moisture is entirely exhausted. Then the encreasing heat immediately produces an expansion, which ascends in conjunction with the fire, making the casts exceed the limits of their first moist state, (provided the composition loses not more than a twentieth part of its volume.) Again, falling from intense heat until quite cold, they descend to a less extent than at their greatest unburnt dryness. Yet, notwithstanding these great, and nearly sudden changes, many subjects are produced perfectly sound.

Fourthly, An equal, and almost impenetrable, firmness, throughout the whole substance, is a most important requisite in that material which deserves the name of artificial stone; a deficiency herein being certain destruction, when exposed to much moisture and severe frosts. For whatever subjects have only their surfaces hardened, whilst their centers remain scarce any thing more than dried clay, must, by the first moist season, be furnished with water sufficient to pervade,
and

and fill all their interstices, so as to increase the volumes of their unburnt centers, which, immediately, or in the first severe frost, must burst to pieces the enclosing crusts: to explain which, it is well known, that clay, being only dried, increases its volume upon the accession of moisture; and experience teaches, that when these fine clayey bodies are burning in subjects of considerable thicknesses, they attain a red heat on their surfaces, some time sooner than in their centers, and if their vitreous ingredients are of the tenderest class, an external vitrification commences too soon; and, of consequence, there must be, either an unequal strength, or the superficies are damaged in hardening the internal substance, or, at best, much time and fuel must be spent in burning, to gain but a poor production. Therefore, to avoid these but too common errors, and bring forth proper effects, the vitrifiable ingredients should be of the most obdurate class, by which means scarce any degree of fusion will be produced, until the heat is intense. Hence the pores are kept or left open till an equal force of fire hath penetrated the whole sub-

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stance;

stance; and then, one pitch of heat performs, nearly all at once, the required vitrification.

It must be granted, that compositions thus formed, are, in the fire, rather hazardous: but no buyer will complain hereof, since the danger lies altogether on the side of the manufacturer.

For any thing less than a due pitch of heat will leave the subjects too soft or weak, even on the surface; and therefore discoverable: whilst on the contrary, a small matter too much of fire will melt down and deface the whole.

By this choice of ingredients, and by nicely adjusting their proportions, a small piece, only a quarter of an inch in thickness, demands the same degree and even durance of heat with others of the largest required magnitudes.

Fifthly, The pores should be small and unconnected, thereby denying to water that free admission and passage, which frequently occasions inconveniencies in natural stone.

The

The advantages arising from this requisite are easily comprehended, since it renders this material much superior, for diverse purposes, to most others in present use.

The means productive hereof are described under the foregoing requisite; for that being properly effected, this follows of course.

Yet, as there are compositions which, by nature, must either be defective herein, or injured in other respects by burning; and as some specimens thereof have been, and may again be offered to the public, an observation or two thereon may not appear unnecessary.

When the vitreous matters are not only of the tenderest class, but also in too small quantities sufficiently to envelope the unvitriifiable ingredients, the cohesion must be weak, consisting only in a few points of contact, thereby leaving the pores large and continued, as in the loosest natural stone. And if some of the unvitriified parts are nearly, and others wholly calx'd, which is too much the case where raw sand is a large ingredient, such stone must imbibe moisture with

near the greediness of common lime, besides having or being liable to all the defects mentioned under the foregoing heads, and will, at best, be no better than ordinary earthen ware.

Such are those compositions whose greatest excellence is cheapness, having for their principal parts natural clays, the other ingredients being only employed as openers, to save the subjects from flying to pieces through a speedy accession of the fire. These, provided they have but a case-hardening heat, will to the eye appear very fair. But a fair appearance should be produced by much better means than slack burning, as will be seen under the next requisite, which was,

Lastly, A bright stone colour; neither the dull redness of common terra cotta's, nor a chalky whiteness, being esteemed agreeable.

A brilliant colour in the finer branches of porcelain-making is reckoned one principal requisite; and, except glazing, is the only thing wherein the English have been excelled by the Chinese.

The difficulties herein arise from our British clays, which contain too considerable

portions of tinging mineral sulphurs, lead and iron.

But the effects of these principles become still more obvious, when exposed to that durance of intense heat requisite to burning large subjects; the two first producing a heavy yellowish opacity, and the last, becoming an imperfect or foul *crocus martis*, yields a dull red colour; to remedy which, as well as other inconveniencies already mentioned, the smallest quantity possible of natural clay should be used, and the other ingredients chosen as described under the head of pure artificial clays. By these means, a small proportion of those colouring being dispersed among larger quantities of colourless materials, they only spread an agreeable tincture over the whole; and notwithstanding these compositions are something more expensive than those under the foregoing head, their additional beauty and strength sufficiently balance the account.

What I have advanced concerning the several requisites of the most perfect artificial stone, may be safely depended upon, being the result of actual experiments, made with

close attention, and is a real description of the composition which I make for common use.

From hence it is very obvious, that the principle of cohesion and strength, in all, and every kind of burnt earth, is a partial vitrification; or in other words, that the bond which unites and holds together their parts, from the coarsest brick, to the finest porcelain, is neither more, nor less, than real glass: all the various denominations of those bodies partaking of one common nature, and differing only in degree of perfection.

It follows too, that the strength of a composition will be proportionate to its fineness or purity, provided always it be sufficiently burnt; for a due degree of heat must ever be considered as essential to strength; and where that due degree is attained, I think I have demonstrated, that those bodies we have been considering, are equal, if not superior, to any known natural bodies, in point of durability. This truth has as many facts and monuments to support it, as would fill a volume to appeal to them distinctly. Some are known to have stood near three thousand,
others

others from two to one thousand years; not to mention abundance of later date, in almost all parts of the world: and there is no reason to be assigned why that which is now made, should not be as durable as the oldest of these monuments. But as I am convinced, that the best composition in the world must fail, unless thoroughly burnt, I would strongly recommend to all whom it may concern, that they take a little pains to become judges in this particular. The experiment I propose to them is easy and certain.

Get of the manufacturer a piece of his burnt composition, not less than an inch thick, break it, and put one half in warm water for some hours, increasing the heat of the water to boiling: then break the watered piece, and it is soon discovered if the center and superficies are equally hard; and if the wet piece be as hard as the dry.

If no failure is found under this test, it is properly burnt, and will never decay in the weather.

Were this caution duly attended to, the manufacture of artificial stone would become

more extensive and useful than most people are aware of.

Of the Use and Application of Artificial Stone.

AS I would treat my subject impartially, I shall begin with pointing out the inconveniencies which attend it. And it is easy to conceive, that a composition made soft enough to cast in a mould, out of which it is to be taken while moist, should incur much hazard, and occasion much trouble, when thrown into a form, whose length is disproportioned to its thickness. To give a more determinate idea of the disproportion I speak of, I shall just mention, that I have produced a piece, near four feet long, nine inches broad, and two inches thick, which was quite straight and sound; but the extraordinary hazard and trouble attending such piece, through every operation, after its discharge from the mould, till it goes into the fire, as well as the danger of warping while in it, must of course add to the expence.

Pieces

Pieces that are very large and unweildy, have also as many inconveniencies, and thus far the use of artificial stone, may seem to be more limited than the natural. But these disadvantages are counterbalanced by a property in the former of holding cement, with a firmness superior to the latter; and the joints may be made as fine as in any material whatever, so that if a subject be too long for its bulk, or too large for convenient management, it can be cut into several pieces, and so joined after burning, as to appear one intire stone.

Again, as those productions are cast in moulds, and the price of the model and mould must fall on the casts that are made from it; so upon single subjects there can be no great saving of expence, unless modelled in the composition itself, which in some cases may be done with advantage: or else, when the subject is so important, that a statuary would make a perfect model in clay, before he carves it in stone; then the making a mould from that clay, and so producing a cast, would save expence on a single subject. Once more: In plain masonry, such

plinths, facies and shafts of columns, Tuscan bases and capitals, and things of like workmanship, there will be little or no saving.

We have now been considering artificial stone under its greatest possible disadvantages; notwithstanding which, it has a just claim to the attention of every builder, not only on account of superior strength and beauty, but of cheapness also, and that in every kind of ornamental work. The saving here is very considerable over natural stone, and that in proportion to the enrichment. As for instance, more in the pound will be saved in Corinthian than in Ionic capitals, and more in these than in Doric.

Besides, things which are scarce practicable in natural stone, or not without prodigious expence, may be produced in this composition at a very moderate rate.

In short, the artificial stone here offered to the public, is equal to every wish of the curious, being little inferior to marble in appearance; not so liable to damage by a blow; when broken, it may be joined with more ease and firmness; and if ever so foul, may
be

be cleaned without the least injury to the surface. The desire of those gentlemen in particular is hereby gratified who have been long in search for a material that would endure the weather, in order to have casts from the best antique statues, bustos, vases, &c. placed on the outsides of their buildings, and in their gardens: an end which cannot be answered by plaister of Paris, neither by lead, in which, as it requires frequent painting, the character is soon lost.

Thus may the most admired works of antiquity be transmitted to the latest posterity.

I cannot avoid mentioning another circumstance in this material favourable to the curious, which is, that in forming a figure, group, or any subject whatever, it is easy to make perforations of various sizes and directions, in a manner almost, if not quite impracticable in any other substance: so that such as are desirous of playing fountains, may indulge the most luxuriant fancy without much extraordinary expence. Nor is it less adapted to inside than outside ornaments. As a specimen I shall only mention chimney-

chimney-pieces, now to be seen at the manufactory, which may with great propriety be brought into the most elegant buildings, being only to be exceeded by statuary-marble itself.

It would be endless to enumerate the subjects of curiosity and use in which the application of this material would obviate those objections which lay against the execution in other materials: the judicious observer will soon make the discovery, the manufactory being open to his inspection.

P O S T-

P O S T S C R I P T.

SINCE the foregoing work was finished and in the press, many fresh instances of disingenuity, prejudicial to this manufacture, have occurred, which obliges me to enlarge on a hint mentioned in the last page of the Introduction.

Many of the masons, and some other workmen, particularly the lesser masters, (for some of the greater deserve praise) notwithstanding they are conscious of superior merit in this manufacture, yet are using their utmost efforts to overturn it; and that by practices so mean that I am almost ashamed to mention them.

One measure they take is by deterring modellers from working for the manufactory; telling them that they will be despised by the whole trade, as forwarding a work it is their interest to suppress.

Again, when their employers signify an inclination to use this material, they immediately

diately cry out, O Sir! why will you have artificial stone? nature must certainly be better than art; it is but an imitation, and a meer makeshift*. Is it not more to your credit to have real stone than to stick up lumps of earthen ware?

This I have known to be the case after they have been sent by gentlemen to examine the material, and when, before my face, they have been forced by conviction, against their will, to acknowledge its great superiority to the best Portland. Even after all this, they have gone back to their employers, and prejudiced them against it by the above false representations.

Much more of this sort might be produced, but this may suffice to caution gentlemen against yielding implicitly to what their workmen say. Were it worth while to retort, I might ask whether our forefathers called the introduction of glass in windows a makeshift, as this was artificial, and horn was natural; and I might, also, with justice call the using natural stone a makeshift, and as poor a one too, in comparison with arti-

* This term has been greatly used.

ficial, as it would now be called to use horn for windows instead of glafs. What is it but a makeshift, for persons, against their inclinations, to alter designs, and put up with an inferior order of architecture, or abate some of the standard ornaments of a superior, to save expence in carving; whilst in artificial stone, there would need no such alteration in design, or abatement of ornament? Certainly I am not too bold in asserting that there is scarce in this kingdom (except the persons above-mentioned) a man to be found so weak as, after due examination, to bestow carving on any kind of English rock-stone whatever.

Some persons, in order to hinder the progress of this work, have asserted that it will not endure above seven years.

I hereby call upon such persons to prove their assertions, provided they do it publicly; for I will not enter into private debates.

T H E E N D.

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